NEW YORK (STATE). CONSERVATION COMMISSION—Power Possibilities of the Saranac River [1915?]

POWER POSSIBILITIES

OF THE

SARANAC RIVER

STATE OF NEW YORK
CONSERVATION COMMISSION
ALBANY

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CONSERVATION COMMISSION

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SARANAC SURVEY

E. S. CULLINGS, Assistant Engineer

F. D. PORTER, Assistant Engineer

THE POWER POSSIBILITIES OF THE SARANAC RIVER

Scope of Investigations

In accordance with the provisions of the Conservation Law which direct the systematic study of the water power resources of the State, a detailed investigation of the storage and power possibilities of the Saranac river was made during the field seasons of 1913 and 1914. The surveys included an accurate profile of the river from Lake Champlain, at Plattsburg, to Saranac Lake village, a survey of the proposed dam site near the foot of Lake Flower, and brief surveys of several undeveloped power sites. All existing power developments on the river were inspected, and data as to the wheel installation, head utilized and use of power were secured. Office investigations, made during the past winter, have included a critical study of all available streamflow and rainfall data, approximate estimates of streamflow at various points on the river, a detailed study of all promising storage basins, an estimate of the cost of the proposed Saranac Lake reservoir, and approximate estimates of the cost of developing some of the undeveloped powers. Thanks are due the local power users for their courteous co-operation, and the use of their files of maps, plans and other data. The field work was done under the supervision of Mr. F. D. Porter, assistant civil engineer, and the office studies were made by Mr. E. S. Cullings, assistant civil engineer.

The Saranac Watershed

The Saranac River has its headwaters in southern Franklin County in the lakes and ponds surrounding Upper Saranac Lake. Draining the three Saranac lakes, it flows northeasterly about 60 miles, and empties into Lake Champlain at Plattsburg. The total area of the watershed is 613 square miles. The upper reaches are mountainous and densely wooded with second-growth timber. The average elevation of the headwaters is about 1,600 feet above

sea level. Between Bloomingdale and Cadyville the descent of the river is precipitous and broken by numerous falls and rapids, having a total fall of nearly 1,000 feet in a distance of 40 miles. Below Cadyville the river flows through a rolling sandy plain, descending to Lake Champlain with an almost uniform grade of 26 feet per mile.

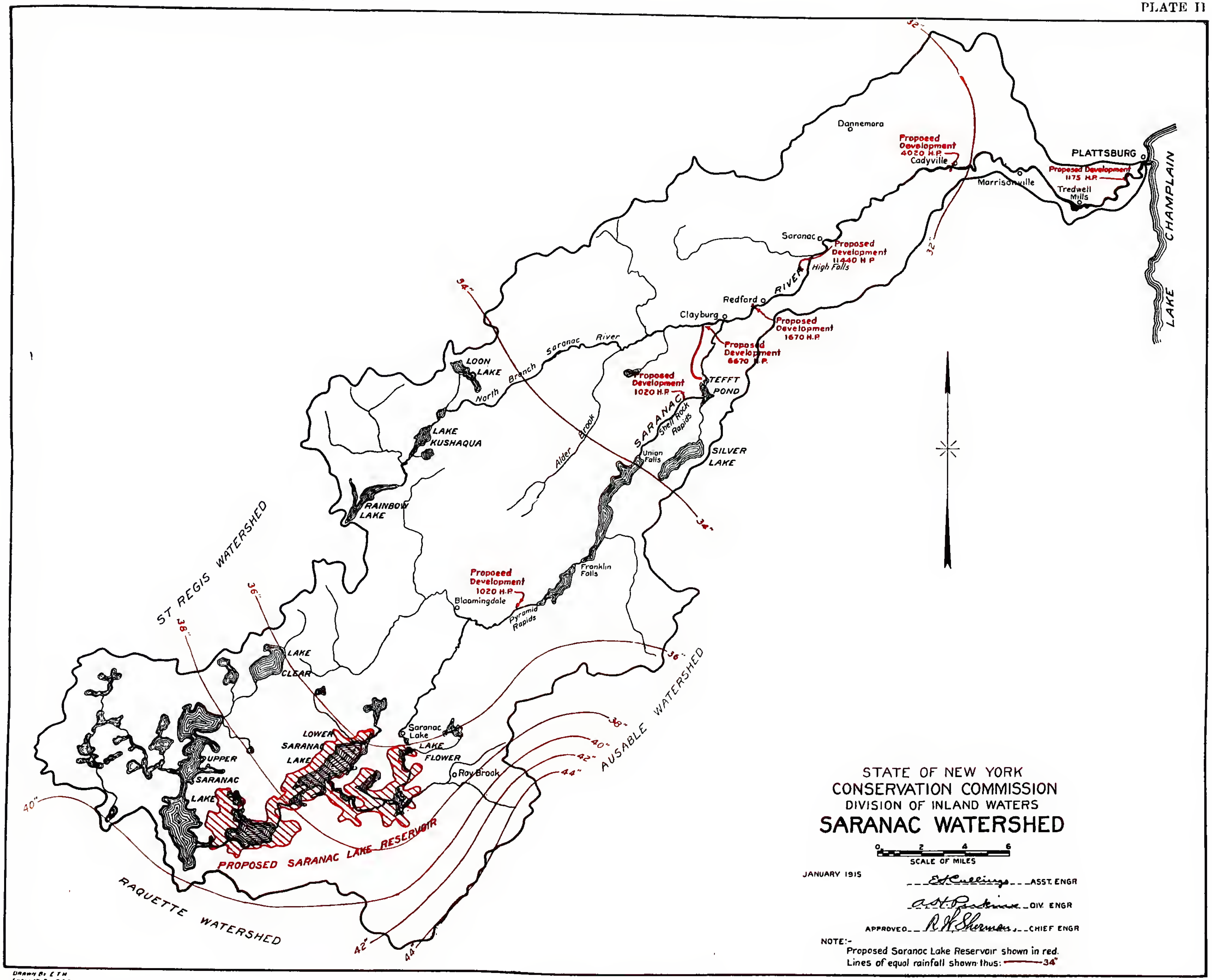
TABLE III

Drainage Areas, Saranac Watershed

	Square miles
Plattsburg (mouth of river)	613
Plattsburg (U. S. G. S. gaging station)	607
Cadyville	576
High Falls	495
Clayburg (below mouth of North Branch)	480
North Branch, at mouth	128
Tefft Pond	347
Union Falls	330
Franklin Falls	293
Pyramid Rapids	280
Saranac Lake Village	185
Bartlett Carry	77

Hydrology

Lying on the easterly side of the Adirondack Plateau, the Saranac watershed receives a somewhat lower precipitation than those lying further to the west. The mean annual rainfall varies from 30 inches at Plattsburg to about 39 inches at Upper Saranac Lake, the average for the watershed being 35 inches. The mean annual temperature at Plattsburg is about 44°F., and at Upper Saranac Lake, about 39°, with a mean of 41° for the whole watershed. The prevailing wind is northwesterly. The annual run-off at Plattsburg during the past 11 years has varied from 12.3 inches (1907) to 20.7 inches (1905), with a mean of 16.4 inches. This amounts to 47 per cent. of the mean annual rainfall, or 1.21 second-feet per square mile of tributary drainage area. The maximum flood discharge recorded during the past 11 years amounted to 6400 second-feet, or 10.5 second-feet per square mile of drainage area.



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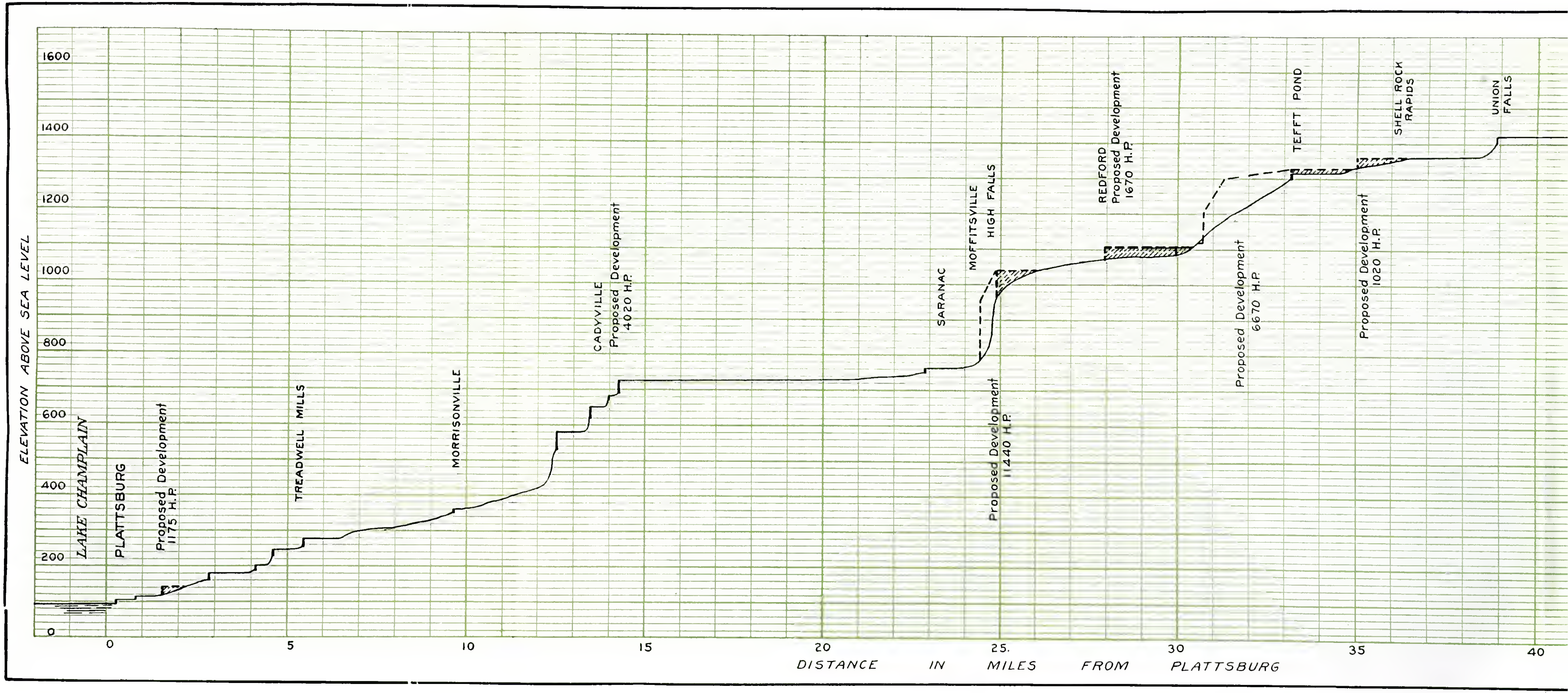
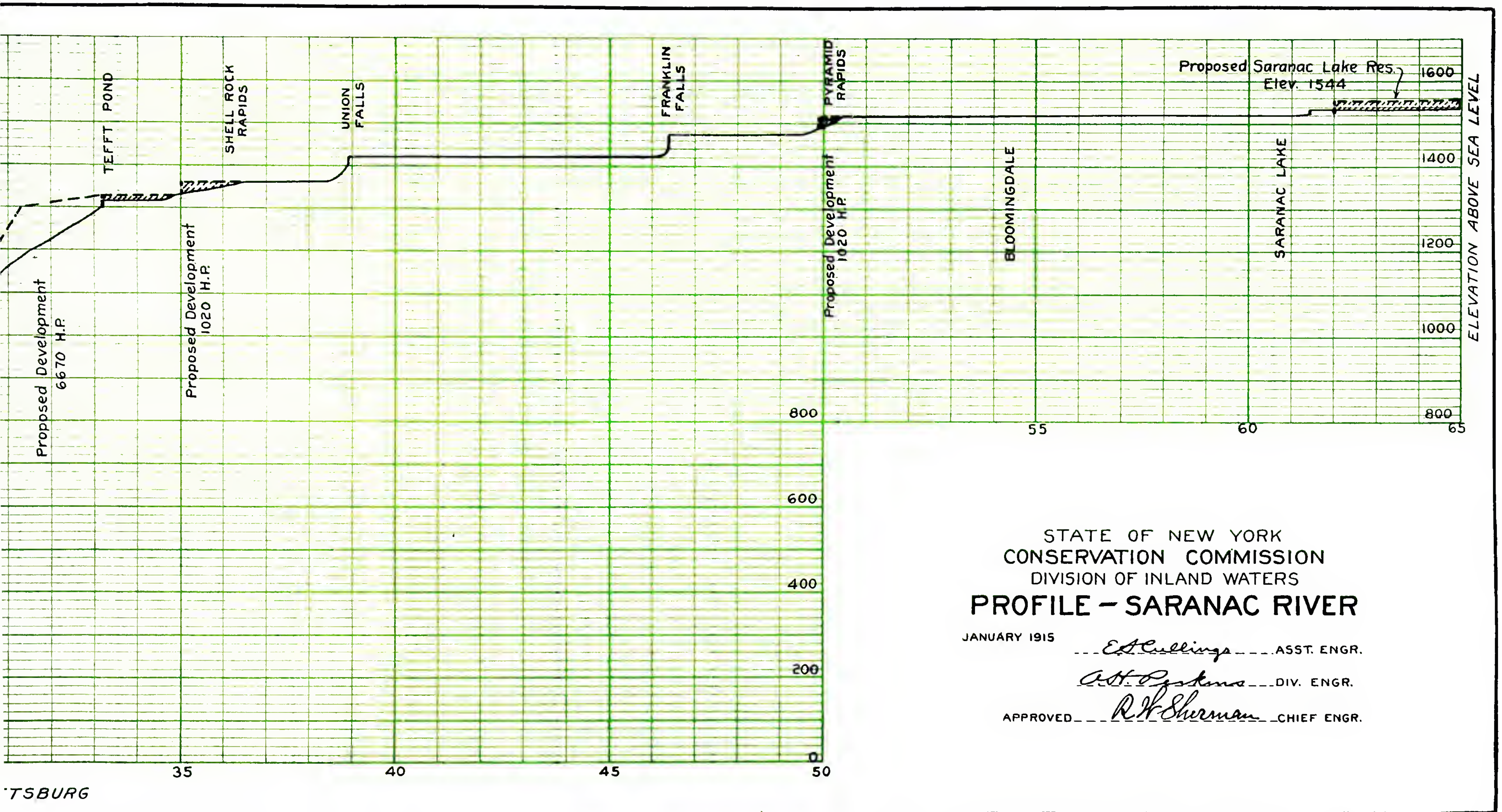
CHECKED BY E.S.C.



ELEVATION ABOVE SEA LEVEL
1600
1400
1200
1000
800
600
400
200
0
LAKE CHAMPLAIN
PLATTSBURG
Proposed Development 1175 H.P.
TREADWELL MILLS
MORRISONVILLE
CADYVILLE
Proposed Development 4020 H.P.
SARANAC
MOFFITSVILLE
HIGH FALLS
Proposed Development 11440 H.P.
REDFORD
Proposed Development 1670 H.P.
Proposed Development 6670 H.P.
TEFFT POND
Proposed Development 1020 H.P.
SHELL ROCK RAPIDS
UNION FALLS
0
5
10
15
20
25.
30
35
40
DISTANCE IN MILES FROM PLATTSBURG


Proposed Saranac Lake Res.
Elev. 1544
TEFFT POND
SHELL ROCK RAPIDS
UNION FALLS
FRANKLIN FALLS
PYRAMID RAPIDS
BLOOMINGDALE
SARANAC LAKE
Proposed Development 6670 H.P.
Proposed Development 1020 H.P.
Proposed Development 1020 H.P.
ELEVATION ABOVE SEA LEVEL
1600
1400
1200
1000
800
600
400
200
0
35
40
45
50
55
60
65
TSBURG
STATE OF NEW YORK
CONSERVATION COMMISSION
DIVISION OF INLAND WATERS
PROFILE – SARANAC RIVER
JANUARY 1915
E.S. Cullings ASST. ENGR.
A.H. Perkins DIV. ENGR.
APPROVED R.W. Sherman CHIEF ENGR.

Streamflow Data

In March 1903, a gaging station was established by the United States Geological Survey at the plant of the Plattsburg Light, Heat and Power Company, just above the city of Plattsburg. The records from this station have been maintained to the present date, and they are the only run-off data available on the Saranac river. Consequently, in the estimates of streamflow shown in Table IV for all points above Plattsburg, it has been necessary to compute the discharge by means of a "conversion factor." This method is based on the formula:

$$Q_1 = \frac{A_1R_1}{A_2R_2} Q_2, \text{ in which}$$

Q_1 = Discharge at the point under consideration.
Q_2 = Known discharge at some other point.
A_1 = Drainage area at the first point.
A_2 = Drainage area at the second point.
R_1 = Mean annual rainfall at the first point.
R_2 = Mean annual rainfall at the second point.

The discharge may be estimated for daily, weekly or monthly periods, but the mean monthly discharge is most commonly used, and this has been used in the estimates following. The above formula is based on the assumption that the run-off at any two points on the same stream will be directly proportional to their respective drainage areas and the mean annual rainfall on each. While this may not be strictly true, the difference in rainfall on the various divisions of the Saranac watershed is not very great, and estimates of run-off so computed should be reasonably accurate.

Seven rain-gaging stations in or near the Saranac watershed have been maintained for periods ranging from 4 to 57 years. Lines of equal rainfall, as shown by these records, have been plotted on the watershed map, Plate II.

Storage Reservoirs

Saranac Lake Reservoir

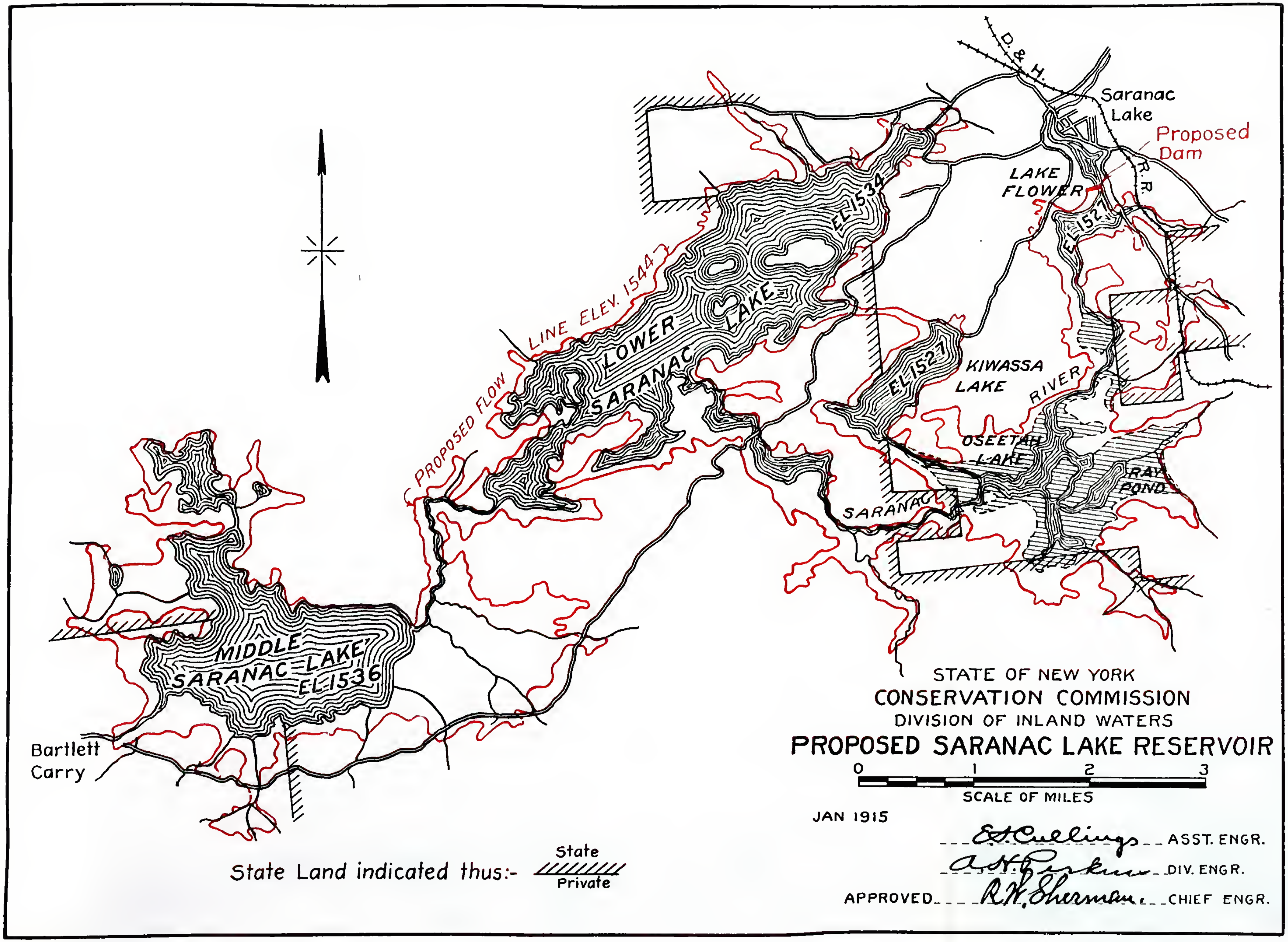
Owing to the exteme fluctuation of the natural streamflow, artificial regulation is one of the prime necessities in the development of the Saranac River. This subject therefore has been given considerable study,

and in course of the surveys of 1913, all promising storage basins were examined. There appears to be only one site where any large quantity of storage can be obtained for a reasonable expenditure. This reservoir site is an irregular-shaped swampy basin above the village of Sananac Lake, including within its area Lake Flower, Oseetah Lake and surrounding swamp and flowed lands, Kiwassa Lake, Lower Saranac Lake, and Middle Saranac Lake and adjacent swamp lands.

At the outlet of Lake Flower a dam with spillway crest at elevation 1,544 feet above sea level, or 17 feet above the low-water surface of the lake would permanently flood all the swamp lands surrounding Lake Flower, Oseetah Lake and Ray Pond. It would raise the surface of Lower Saranac Lake by 10 feet, and middle Saranac Lake by 8 feet, submerging all surrounding swamp lands. With a draft of 10 feet, the proposed reservoir would have a capacity of 4.0 billion cubic feet, sufficient to completely regulate the tributary drainage area of 185 square miles, and yet leave at all times enough water in the reservoir to completely cover all the flowed lands surrounding Lake Flower and Oseetah Lake. During the entire navigation season there would be sufficient water for uninterrupted navigation (without the use of locks) from the regulating dam to Bartlett Carry.

Though, as yet, no borings have been made, the dam site appears to be a favorable one; both banks of the river are of firm compact glacial material, and the bed is of gravel and small stones. The indications are that ledge rock lies at no great distance below the bed of the stream. Owing to the fact that the rock surface has not been definitely located, a reinforced concrete dam with cut-off wall extending to rock has been considered in the following estimate of cost. If ledge rock is found to be near the surface, a solid masonry dam can be built at about the same cost.

Property damage will not be excessive. A total of only about thirty-five cottages will be affected, and in many cases these cottages can, at no great expense, be moved back to higher ground. Boat houses will have to be rebuilt, taking into account the fluctuation which will occur during the navigation season. The total area included within the proposed flow line is 11,500 acres,


D.&H. R.R.
Saranac Lake
Proposed Dam
LAKE FLOWER
EL. 1527
EL. 1534
PROPOSED FLOW LINE ELEV. 1544
LOWER SARANAC LAKE
EL. 1527
KIWASSA LAKE
RIVER
OSEETAH LAKE
RAY POND
SARANAC
MIDDLE SARANAC LAKE EL. 1536
Bartlett Carry
State Land indicated thus:-
State
Private
STATE OF NEW YORK
CONSERVATION COMMISSION
DIVISION OF INLAND WATERS
PROPOSED SARANAC LAKE RESERVOIR
0 1 2 3
SCALE OF MILES
JAN 1915
E. S. Cullings ASST. ENGR.
A. H. Perkins DIV. ENGR.
APPROVED R. W. Sherman CHIEF ENGR.

STATE OF NEW YORK
CONSERVATION COMMISSION
DIVISION OF INLAND WATERS

AREA AND CAPACITY CURVES
PROPOSED SARANAC LAKE RESERVOIR

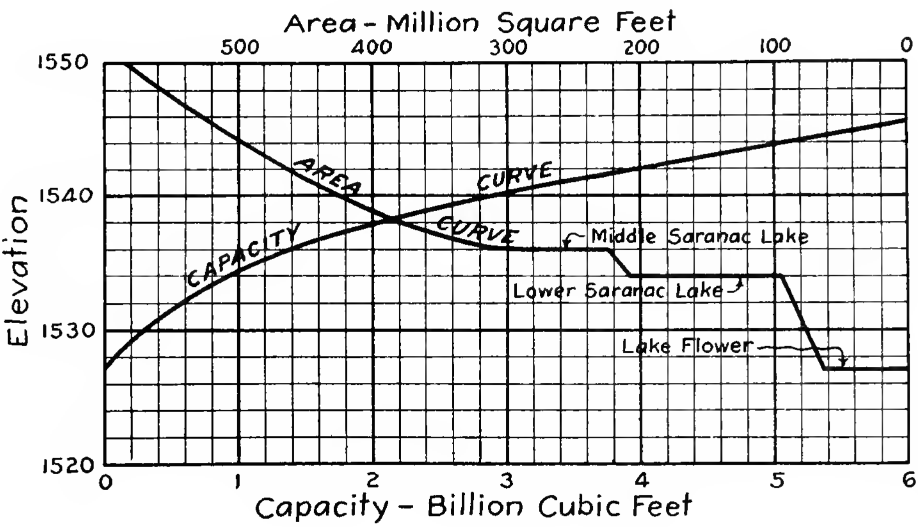
JANUARY 1915

E. S. Cullings ASST ENGR.

A. H. Perkins DIV. ENGR.

APPROVED R. W. Sherman CHIEF ENGR.

Proposed flow line, elevation 1544.
Maximum depletion, 10 feet.
Capacity, 4.0 billion cubic feet.



of which nearly half (5,500 acres) is natural water surface. Of the 6,000 acres of land to be submerged, all but about 1,300 acres is the property of the State. It will be necessary to relocate or reconstruct about two miles of the Delaware and Hudson railroad, and about 2.5 miles of highway.

The shores and all flowed land within the reservoir basin should be entirely cleared of standing timber, and all stumps and partially submerged "dead-heads," which now prove such a menace to navigation, should be removed.

The cost of the proposed reservoir is estimated as follows:

Land	$42,000
Clearing and grubbing	140,000
Relocating highway and bridges	30,000
Relocating railroad	40,000
Damage to cottages and boat houses	150,000
Dam and outlet works	132,000
Engineering and contingencies, 15 per cent.	80,000
Total	$614,000
Cost per million cubic feet	$153 50

The creation of this reservoir is highly desirable for summer resort, health and pleasure purposes, as well as for power, but inasmuch as "business and pleasure" can here be so admirably combined, the needs of the water powers should probably receive first consideration, and the powers benefited should bear the greater part of the burden of financing the project. However, the value of all property in the vicinity of the reservoir will be materially enhanced, and therefore this property should bear its proportionate share of the construction and maintenance costs.

Upper Saranac Lake

At its outlet, Upper Saranac Lake has a drainage area of 77 square miles. Sufficient storage for the complete regulation of this area is easily obtainable, but inasmuch as complete regulation is provided for in the proposed reservoir above described, the upper reservoir will be unnecessary.

Bloomingdale Swamp

Betweeu the villages of Saranac Lake and Bloomingdale, a distance of about six miles, the river flows through an extensive swamp having an area of not less than 2,200 acres, which might be flooded to a depth of from 20 to 25 feet by a dam at the head of Pyramid Rapids, a short distance below Bloomingdale. Additional storage to the amount of about 2.0 billion cubic feet would be available, but the cost, from property damage alone, would be prohibitive. A large part of the business section of Saranac Lake village would be submerged, and about ten miles of new State road would have to be relocated. The project therefore is not considered feasible.

Franklin Falls

A small amount of storage has already been obtained at this place. By increasing the height of the dam by 10 feet, a total storage of about 0.35 billion cubic feet can be obtained without seriously interfering with the operation of the power plant.

Union Falls

About 0.50 billion cubic feet of storage is now available at this place. This amount can be doubled by increasing the height of the dam by 8 feet, but this increase would interfere somewhat with the operation of the Frankling Falls plant.

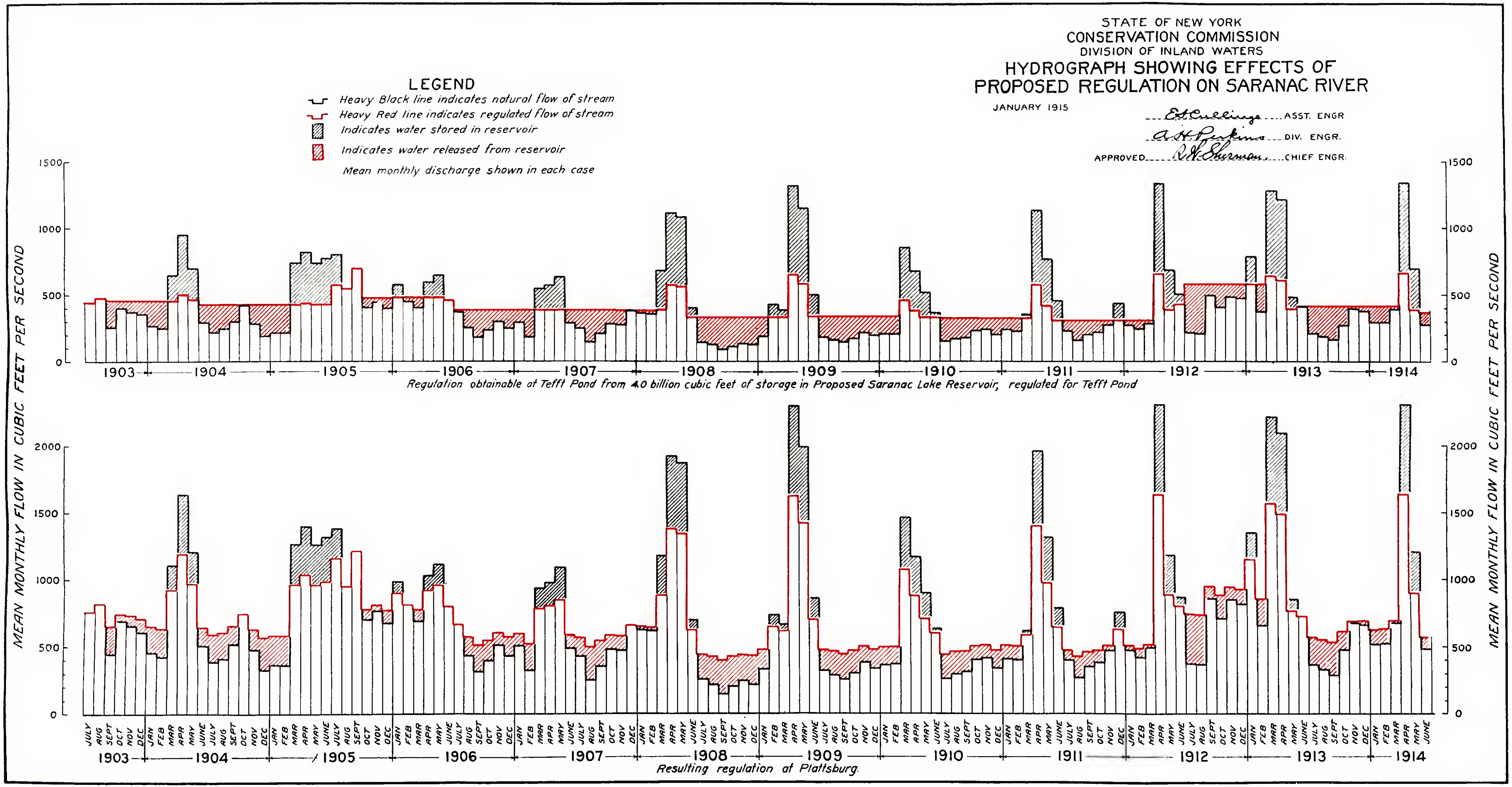
Tefft Pond

The amount of storage here available does not exceed 0.10 billion cubic feet, an amount so small that it can hardly be considered other than as "pondage" for the proposed power development hereinafter described.

Lake Kushaqua

The North Branch is almost entirely lacking in reservoir possibilities, though a small amount of storage has been privately developed at Lake Kushaqua. The storage capacity of the lake does not exceed 0.15 billion cubic feet, and it cannot be materially increased. This storage is at present used chiefly for log driving in the spring, and under ordinary conditions, the reservoir is maintained at spillway level during the summer months.

All of the small reservoirs above mentioned will be of some value in the regulation of the river, and collectively they can be so manipulated as to provide at least 1.0 billion cubic feet of storage. At present they are all under private control and they


STATE OF NEW YORK
CONSERVATION COMMISSION
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HYDROGRAPH SHOWING EFFECTS OF
PROPOSED REGULATION ON SARANAC RIVER
JANUARY 1915
E.S. Cullings ASST. ENGR
A.H. Perkins DIV. ENGR.
APPROVED R.W. Sherman CHIEF ENGR.
LEGEND
Heavy Black line indicates natural flow of stream
Heavy Red line indicates regulated flow of stream
Indicates water stored in reservoir
Indicates water released from reservoir
Mean monthly discharge shown in each case
MEAN MONTHLY FLOW IN CUBIC FEET PER SECOND
1903
1904
1905
1906
1907
1908
1909
1910
1911
1912
1913
1914
Regulation obtainable at Tefft Pond from 4.0 billion cubic feet of storage in Proposed Saranac Lake Reservoir, regulated for Tefft Pond
Resulting regulation at Plattsburg.

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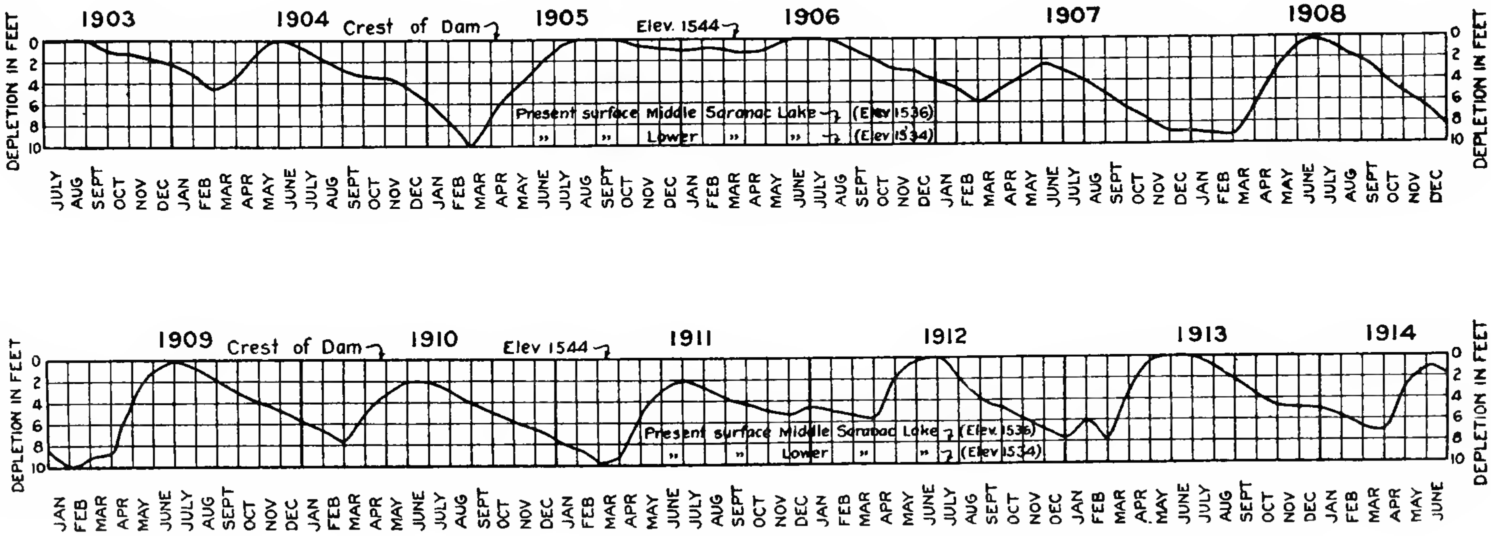


EXPLANATION:-
This curve shows the depletion in feet below the spillway crest, which would have occured, had the reservoir been in operation during the past 11 years

STATE OF NEW YORK
CONSERVATION COMMISSION
DIVISION OF INLAND WATERS
DEPLETION CURVE
PROPOSED SARANAC LAKE RESERVOIR

JANUARY 1915

E. S. Cullings ASST ENGR.
A. H. Perkins DIV. ENGR
APPROVED R. W. Sherman CHIEF ENGR

have not been considered in the estimates of streamflow and available power, shown in Table IV. This table shows the benefits which will result from the proposed Saranac Lake reservoir only. However, with these smaller reservoirs in use, even with present capacities, the total amount of power available will be somewhat higher than that shown in the table.

Method of Operating Reservoirs In the use of stored water through a number of plants at various distances from a storage reservoir, it is obvious that, due to the inflow of tributary streams below the reservoir equally good regulation cannot be secured at all points. Each reservoir must be so regulated as to provide, as nearly as possible, a uniform year-round flow at some definite point on the stream. Under ordinary conditions this point should be so selected that, within the economic wheel installations at the various plants, a maximum amount of energy will be added to the stream as a whole. If, however, this plan is strictly followed, it may be necessary at certain times, while the reservoir is filling, to completely close the outlet gates, and thus entirely, or very nearly, shut off all flow from a plant located at, or near, the reservoir. Such would be the case with the power and pumping plants at Saranac lake. It will therefore be necessary to determine a just and equitable minimum flow which should be maintained at this point while the reservoir is filling, even though some plants at points further down stream have more water than they can use. At Saranac Lake, the average monthly flow for the lowest month each year for the past 11 years has amounted to about 100 cubic feet per second, and in 1908 the mean flow for the month of September amounted to only about 50 cubic feet per second. Therefore, for the purposes of this study, it has been tentatively assumed that the interests of all will be best served if a minimum flow of 100 cubic feet per second be maintained at this point while the reservoir is filling. This has the effect of shifting the period of low flow from the summer to the spring months. The following estimates of regulated flow are based on this method of operation.

A careful study of the profile of the Saranac River, and of the power developments thereon, indicates that the proposed reservoir should be so operated as to give, as nearly as may be, an

even flow at a point near the mouth of the North Branch. Therefore, in the following studies it has been assumed that the Saranac Lake reservoir will be operated for best results at the proposed Tefft Pond power development. On this basis, mass curves and the resulting "power-percentage-of-time" curves have been computed and plotted, and from these curves, the resulting benefit at each of the existing plants, and at all undeveloped sites has been deduced.

Power Developments and Possibilities

Basis of Comparison

The economic development of a water power usually requires a wheel capacity considerably in excess of that required for the minimum flow of the stream. Depending somewhat on the purpose for which the power is used, a turbine installation of sufficient capacity to utilize the whole flow of the stream for from six to eight months each year is usually economical; and if continuous year-round power is required, the deficiency during the low-water period is supplied by an auxiliary plant. For the purpose of reducing all plants and undeveloped power sites to a common basis of comparison in this discussion, a wheel installation which can run at full capacity 60 per cent. of the average year (7.2 months) has in each case been adopted as the economic development for either natural or regulated flow.

All estimates of streamflow are based on mean monthly discharges. These flows will, of course, be subject to certain daily or weekly variations caused by the manipulation of pondage at plants further up stream, but in most cases, particularly at the undeveloped power sites, sufficient pondage can be obtained to eliminate, to a great extent, the effects of such manipulation.

Owing to the impossibility of making, within the time allotted to this work, a thorough sub-surface investigation at each of the undeveloped power sites, we have been able to prepare only very rough estimates of the cost of developing these powers, but liberal assumptions have been made, and it is believed that these estimates are sufficiently accurate to form a fair basis of comparison of the relative merits of the various projects. Hydro-electric

Swampy Shore of Middle Saranac Lake

Flowed Land, Oseetah Lake

Present Shore Line, Oseetah Lake

Present Shore Line, Lake Flower

Proposed Dam Site — Saranac Lake Reservoir

Pyramid Rapids Power Site

development has been assumed in each case, but the estimates for electrical apparatus do not include transformers or transmission lines. The cost of acquiring land and riparian rights is not included.

The following statements briefly summarize the principal physical conditions at each of the existing plants and at undeveloped power sites. The details of both present and proposed developments are shown in Table IV, following page 17.

Plattsburg First Dam

In the vicinity of Plattsburg there are six dams creating an aggregate head of 128 feet. There is also one undeveloped site where a head of 21 feet can be obtained. The first of these dams is a crib structure about 12 feet high and 350 feet long. About half of the available flow under 15 feet of head is used by a paper mill, and most of the remainder, under 13 feet of head, is used by a pulp mill at the southerly end of the dam. Two small factories at the northerly end of the dam have rights to a part of the "surplus" water. There appears to be no physical reason why the whole flow should not be used through the maximum available head of 15 feet, and the entire power developed at a single plant. A considerable increase in power could thus be obtained.

Second Dam

About one-half mile up stream is a timber crib dam having a height of about 9 feet and a length of about 190 feet. At the easterly end an electric power plant utilizes about 50 per cent. of the streamflow, while the remainder is divided between a grist-mill and a machine shop on the westerly bank. A slight increase in head might be obtained by the use of flashboards.

Third Dam

This is a concrete structure located about two miles from the mouth of the river. A head of 22 feet is created and power is used in a paper mill on the southerly bank of the river.

Fourth Dam

An electric power plant here utilizes a 14-foot head created by a concrete dam. The United States Geological Survey has for the past 11 years maintained a stream-gaging station at this place.

Fifth Dam

A crib dam about 30 feet high and 550 feet long, with a 12-foot steel penstock about 400 feet long creates at this place a head of 42 feet. Power is used in a steel plant.

Sixth Dam

At Treadwell Mills a concrete dam makes available a head of 27 feet, power from which is utilized in the operation of a pulp mill.

Undeveloped Site

Just above the highway bridge between the second and third dams above described, is a favorable opportunity for the development of a 21-foot head. At this point the bed of the river is of solid rock, and the banks are partly of rock and partly of firm impervious soil. A concrete dam not over 20 feet high above stream bed, and about 400 feet long, with a canal or head race carrying the water about 500 feet down stream to the power house site on the easterly bank of the river, would create a gross head of 23 feet. The average net working head is estimated at 21 feet. With the regulated flow due to 4.0 billion cubic feet of storage in the proposed Saranac Lake reservoir, there would be available at all times a flow of about 405 cubic feet per second, and for 60 per cent. of the average year, a flow of about 615 cubic feet per second. These flows, with the given head, would produce, at 80 per cent. efficiency, 773 and 1,175 horsepower, respectively. There are not sufficient physical data at hand for an accurate estimate of cost, but based on an installation of 1,200 horsepower, the construction cost should not exceed $100 per horsepower.

Morrisonville

From the crest of the Treadwell Mills dam to the tailwater of the lower mill at Cadyville, a distance of about 6 miles, the river has an even grade of 23 feet per mile, the gross fall being 139 feet. The only power development in this section of the river is that at Morrisonville, where the streamflow is divided between a grist-mill on the southerly bank, using a 9-foot head, and a sawmill at the northerly end of the dam, utilizing about 7 feet of fall. At several points small heads, ranging from 10 to 12 feet might be developed, but owing to the great breadth of the river channel and the lack of suitable foundations, it is probable that under present conditions these powers would not be found economical.

STATE OF NEW YORK

CONSERVATION COMMISSION

DIVISION OF INLAND WATERS

POWER-PERCENTAGE-OF-TIME CURVES

SARANAC RIVER AT TEFFT POND

JANUARY 1915

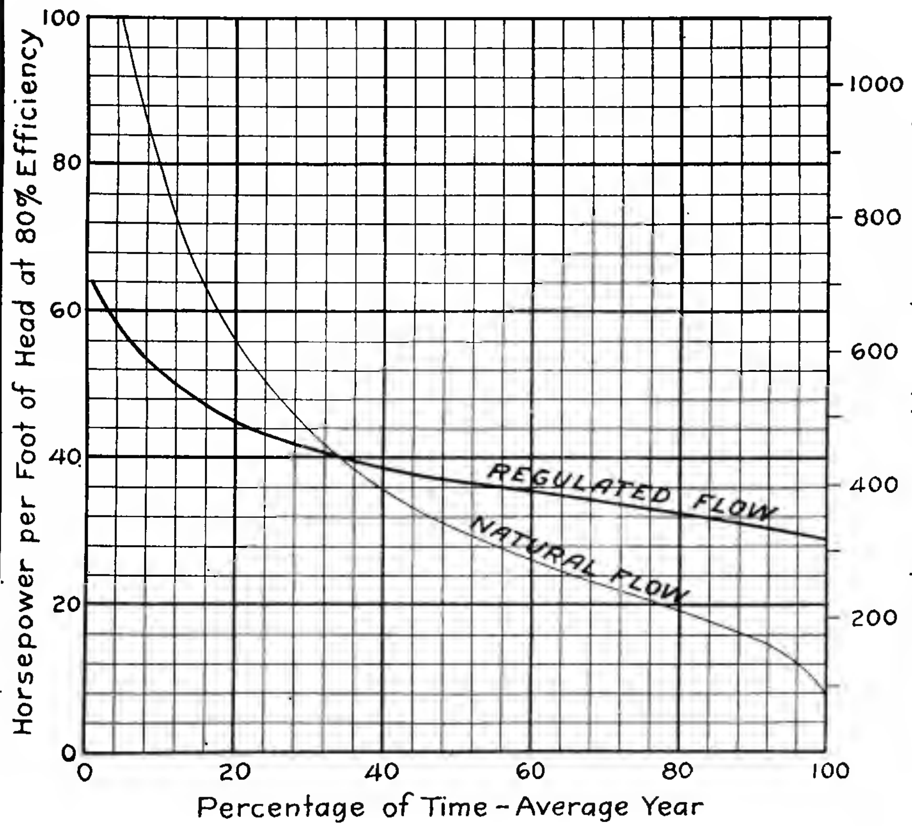
E. S. Cullings ASST ENGR

A. H. Perkins DIV. ENGR.

APPROVED R. W. Sherman CHIEF ENGR.

NOTE:-

Regulated flow line shows resulting regulation from 4.0 billion cubic feet of storage in proposed Saranac Lake Reservoir.



Cadyville Lower Mill A concrete dam of multiple-arch type here diverts water into a steel penstock through which it is conveyed to a pulp mill about 2,200 feet down stream from the dam. The gross head is about 159 feet. This is the largest power development on the Saranac river.

Upper Mill A rocky gorge at this point is closed by a masonry dam about 60 feet high, and less than 200 feet long. The gross head of 65 feet is completely developed. Power is used in a pulp mill near the northerly end of the dam.

Undeveloped Head A third development has already been started at this place. The dam is located at a point about one-half mile above the Delaware and Hudson railroad bridge, where a narrow rock gorge from 40 to 50 feet deep, with vertical banks, affords an ideal site for the masonry dam, which is already in place. With a steel penstock, or other conduit carrying the water to the pool of the upper mill above noted, a total head of 78 feet will be available. With the proposed regulation, a continuous power output of about 2,700 horsepower can be maintained, and for 60 per cent. of the average year, about 4,000 horsepower will be available.

Saranac The next power devolopment is a grist-mill at the village of Saranac, where a head of about 8 feet is created by means of a crib dam. By deepening and enlarging the tailrace and using 12-inch flashboards during the low-water period, this head might be increased to 11 feet.

High Falls This gorge, with its precipitous descent of 200 feet within a distance of less than half a mile, offers a remarkable opportunity for power development. A narrow gorge at the head of a series of falls and rapids with its almost vertical banks of solid granite rock affords an economical site for a dam. In the suggested scheme for development, a steel conduit, barely 2,000 feet long, would carry the water to a surge tank on the top of the high bank on the westerly side of the river nearly opposite the foot of the falls. This tank in turn would be connected with the power house by smaller steel penstocks about 500 feet long. The power house site is about 200 feet below the foot of the falls. With a dam 60 feet high, or to elevation 1,035 (above sea level), a working head of not less than 242 feet can

be made available. With the proposed regulation, a minimum flow of about 380 cubic feet per second can be maintained, and for 60 per cent. of the average year, about 520 cubic feet per second. These flows with the given head would produce 8,360 and 11,440 horsepower, respectively.

The approximate cost of this development, as outlined above, and based on an installation of 12,000 horsepower, is estimated as follows:

Dam and headworks	$116,000
Ten-foot riveted steel conduit...........	61,300
Surge tank, penstocks, etc..............	44,000
Power house	32,000
Hydraulic and electrical machinery......	120,000
Engineering and contingencies, 15 per cent.	56,700
Total	$430,000
Cost per horsepower, exclusive of land and riparian rights	$35.83

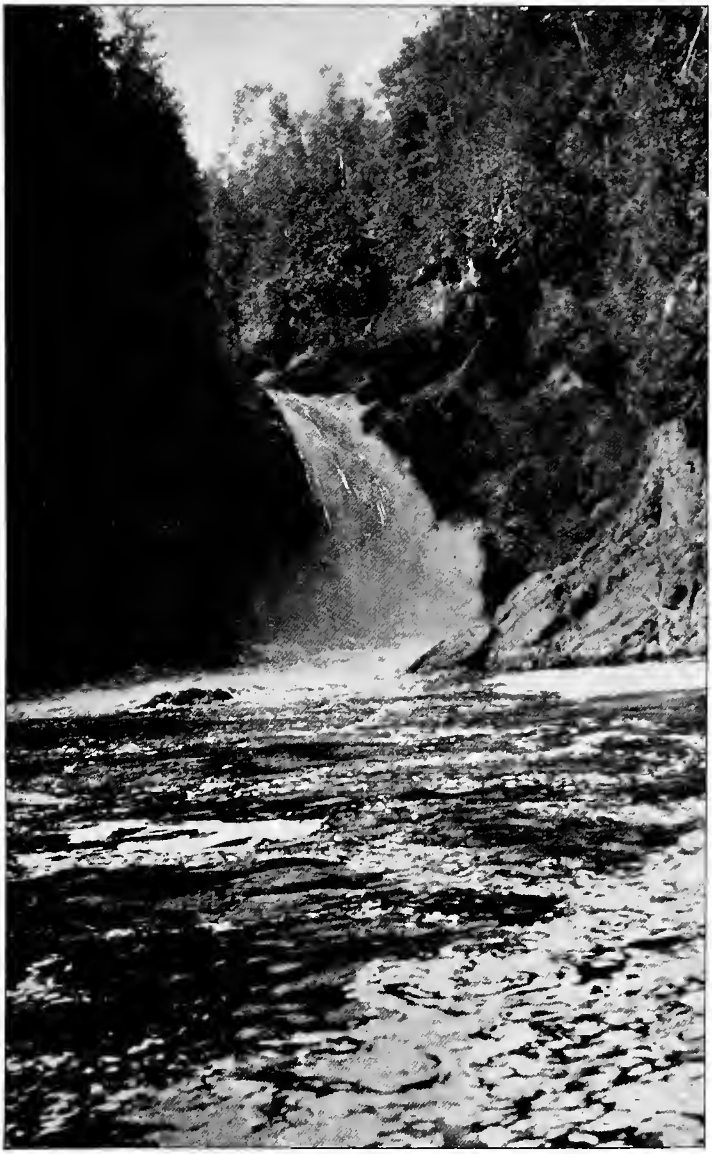
This development cost is extremely low; assuming so low a figure as $100 per horsepower as the amount which can be economically invested in a water power development, it is seen that this plant alone could bear the entire cost of the proposed Saranac Lake reservoir.

Redford

At the site of an old blast furnace near the village of Redford, a working head of 36 feet is available. The proposed scheme of development includes a masonry dam at a point near the site of the former blast furnace dam, and a short canal leading to a point near the northerly end of the highway bridge. Short steel penstocks would connect with the power house, immediately below the highway. This plan would make necessary the relocation of about one mile of the highway between Redford and Clayburg, but other property damage would be trifling. Sufficient data for an estimate of cost of this

High Falls Power Site — Upper Falls

High Falls Power Site — Middle Falls



High Falls Power Site — Lower Falls

STATE OF NEW YORK
CONSERVATION COMMISSION
DIVISION OF INLAND WATERS

POWER-PERCENTAGE-OF-TIME-CURVES
SARANAC RIVER AT HIGH FALLS

JANUARY 1915

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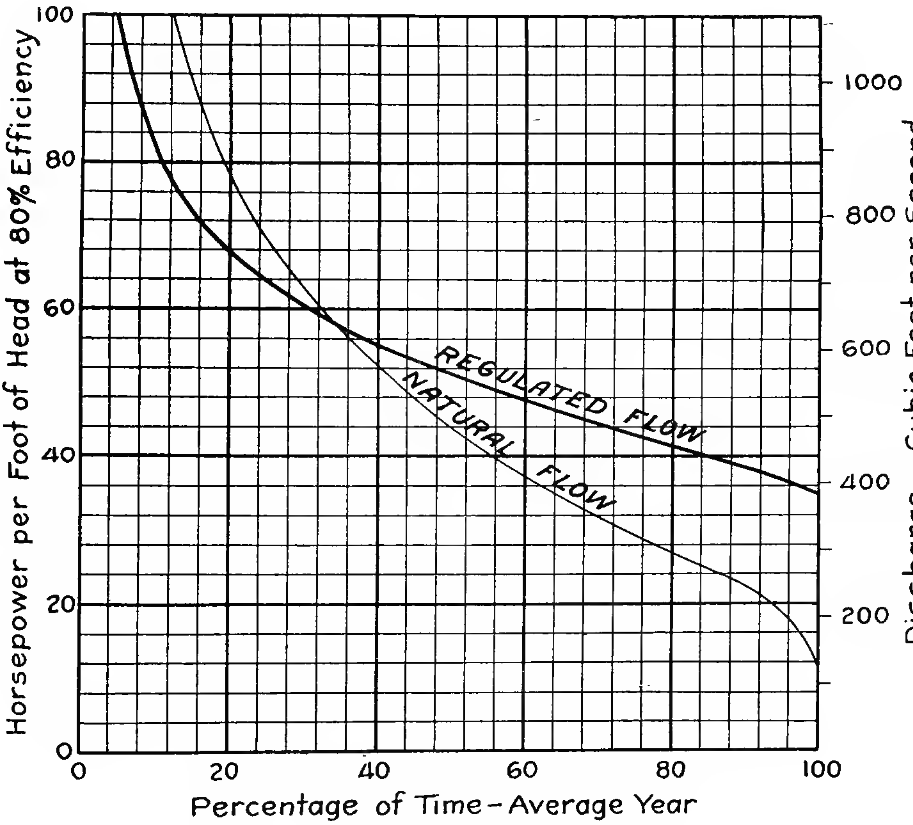
NOTE:–
Regulated flow line shows resulting regulation from 4.0 billion cubic feet of storage in proposed Saranac Lake Reservoir.



project are not available, but with regulated flow and an installation of 1,700 horsepower, the cost should not exceed $100 per horsepower.

Tefft Pond

Between the crest of the present dam at Tefft pond and the water surface at the mouth of the North Branch at Clayburg, there is a gross fall at 202 feet. There are, however, between these two points, few sites where dams can be economically located. Therefore, the most feasible scheme seems to be to raise the height of dam at Tefft pond by about 10 feet, providing additional pondage as well as head, and to convey the water under low head through a reinforced concrete or steel conduit about 14,000 feet long to the high bank on the north branch about one-half mile above the Clayburg bridge. This bank offers a practicable site for a surge tank, from which short penstocks would lead to the power house on the southerly bank of the North Branch. In this way a net working head of about 188 feet can be secured. With regulated flow, about 5,470 continuous 24-hour horsepower would be available, and for 60 per cent. of the average year, about 6,670 horsepower. The construction cost, based on an installation of 6,800 horsepower, is estimated at $638,000, or $93.80 per horsepower.

Shell Rock Rapids

At the foot of this rapids the river flows through a narrow gorge, less than 100 feet wide, with vertical rock banks to a height of from 35 to 40 feet. A dam 30 feet high above low-water level would back water to the tail-race of the Union Falls plant, about 3 miles up stream. A working head of 30 feet would be available. This head, with regulated flow, would produce about 850 horsepower of continuous all-year power, or about 1,000 horsepower for 60 per cent. of the average year. The estimated cost is $100,000, or $100 per horsepower.

Union Falls

A masonry dam about 150 feet long and not over 15 feet high, with an 11-foot steel penstock about 1400 feet long, here creates a gross head of 57 feet. Electric power is developed for use in surrounding towns and

villages. This dam creates a small reservoir having an area of about 1500 acres, and a capacity of perhaps 0.50 billion cubic feet.

Franklin Falls At this place a head of 52 feet is created by means of a masonry dam about 35 feet high, and a 10-foot steel penstock about 300 feet long. Electric power is developed and used with the power from the Union Falls plant. A small amount of storage has also been secured at this plant. The reservoir has an area of about 450 acres, and a capacity of perhaps 0.15 billion cubic feet.

Pyramid Rapids Between the Franklin Falls reservoir and the foot of the Bloomingdale swamp, the river has a fall of 45 feet. Of this head, at least 34 feet can be developed by means of a masonry dam 24 feet high, located at a point near the middle of the rapids, with a reinforced concrete or steel conduit about 950 feet long, leading to the power house site. With the proposed regulation, about 750 continuous 24-hour horsepower would be available, and for 60 per cent. of the average year, about 1000 horse power. The estimated cost is $110,000 or $110 per horsepower.

Saranac Lake The flow of the river is here divided between the village pumping plant, located at the easterly end of the dam, and an electric power plant at the westerly end. The power plant is connected with those at Union Falls and Franklin Falls, and has been but little used since the construction of those plants. The pumping plant supplies the village with water, and is operated continuously. The average head is about eleven feet.

TABLE IV—Summary of Effects of Proposed Storage on Saranac River

LOCATION	Nature of business	PRESENT CONDITIONS										CONDITIONS AFTER REGULATION BY 4.0 BILLION CUBIC FEET OF STORAGE IN PROPOSED SARANAC LAKE RESERVOIR, REGULATED FOR TE										
		Drainage area; Square miles	Elevation of crest of dam or top of flash-boards (Above sea level)	Average working head; feet	Rated horse-power capacity of turbines	Estimated minimum monthly flow in second-feet	Continuous 24-hour h. p. available at 80 per cent. efficiency	Power available in average year with installation in Column VI h. p.-years per annum	Estimated available flow for 60 per cent. of average year	Capacity of turbines at 80 per cent. efficiency for 24-hour power 60 per cent. of average year	Power available in average year with flow in Column X and installation in Column XI h. p.-years per annum	Power added to natural stream flow by proposed reservoir with present installation and head h. p.-years per annum	Elevation of proposed crest of dam or top of flashboards	Ultimate working head	Minimum regulated flow in second-feet, dryest year	Continuous 24-hour h. p. available, dryest year	Regulated flow available for 60 per cent. of average year	Capacity of turbines at 80 per cent efficiency for 24-hour power 60 per cent. of average year	Power supplied by natural flow with installation in Column XIX h. p.-years per annum	Additional power afforded by proposed regulation in average year, after economic development, h. p.-years per annum	Total hydraulic power available in average year, h. p.-years per annum. (Sum of Column XX and Column XXI)	At REQU CON I Ra horsep
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XX
DEVELOPED POWERS:																						
Plattsburg, first dam	Paper and pulp mill	613	112	14	1,190	150	191	644	400	510	485	77										
Plattsburg, first dam	Not in use (23½% of surplus water)	613	112	10	70*	....	....	40	60	55	39	14	112	15	405	562	615	840	682	105	787	
Plattsburg, first dam	Excelsior mill (10% of surplus water)	613	112	9	100*	....	....	33	25	20	14	7										
Plattsburg, second dam	Power plant (50% of stream flow)	613	121	9	615	75	61	293	243	199	176	17										
Plattsburg, second dam	Grist mill (25% of stream flow)	613	121	9	190	37.5	31	124	121	99	88	16	122	10	405	368	615	559	454	70	524	
Plattsburg, second dam	Machine shop (25% of stream flow)	613	121	9	125	37.5	31	102	121	99	88	15										
Plattsburg, third dam	Paper mill	608	183	22	1,950	150	300	1,230	485	970	860	150	183	22	405	810	615	1,230	998	154	1,152	
Plattsburg, fourth dam	Power plant	607	206	14	840	150	191	659	485	618	648	103	206	14	405	516	615	783	635	98	733	
Plattsburg, fifth dam	Steel mill	607	249	42	2,500	150	573	1,960	485	1,850	1,640	308	249	42	405	1,546	615	2,350	1,907	294	2,201	
Plattsburg, sixth dam	Pulp mill	606	281	27	2,380	150	368	1,500	485	1,190	1,050	185	281	27	405	995	615	1,510	1,227	189	1,416	
Morrisonville	Grist mill (50% of stream flow)	584	362	9	150*	70	57	142	235	192	171	8	362	9	400	327	595	487	395	62	467	
Morrisonville	Saw mill (50% of stream flow)	584	362	7	150*	70	45	132	235	150	133	16										
Cadyville, first dam	Pulp mill	576	579	156	6,600	140	1,985	5,830	460	6,520	5,860	690	579	156	395	5,600	590	8,370	6,782	1,082	7,864	
Cadyville, second dam	Pulp mill	576	648	65	4,200	140	827	3,050	460	2,720	2,440	518	648	66	395	2,335	590	3,485	2,824	450	3,274	
Saranac	Grist mill	520	758	8	75*	130	95	75	420	306	272	....	750	11	385	385	540	540	435	75	510	
Union Falls	Power plant	330	1,408	57	1,500	85	440	1,330	275	1,425	1,205	166	1,408	57	300	1,552	375	1,942	1,542	348	1,890	
Franklin Falls	Power plant	293	1,462	52	1,750	75	354	1,290	245	1,158	1,040	308	1,462	52	260	1,230	340	1,607	1,262	296	1,558	
Saranac Lake	Power plant (50% of stream flow)	185	1,527	11	450	25	25	122	82	82	73	....	1,527	11	100	100	235	235	180	25	205	
Saranac Lake	Pumping plant (50% of stream flow)	185	1,527	11	215	25	25	111	83	83	73	10										
Total — Developed powers		....	....	485	25,050	....	5,599	18,676	....	18,246	16,305	2,607	....	491	....	16,316	....	23,938	19,323	3,248	22,571	
UNDEVELOPED POWERS:																						
Plattsburg		612	....	21	....	150	286	....	485	925	825	....	148	21	405	773	615	1,176	953	147	1,100	
Cadyville		576	....	75	....	140	955	....	460	3,136	2,810	....	726	76	395	2,605	590	4,020	3,256	520	3,776	
High Falls		495	....	242	....	120	2,640	....	405	8,910	7,870	....	1,035	242	380	8,360	520	11,440	9,215	1,620	10,836	
Redford		486	....	36	....	120	303	....	395	1,290	1,150	....	1,102	36	375	1,228	510	1,670	1,342	240	1,582	
Tefft Pond		347	....	188	....	85	1,460	....	285	4,870	4,370	....	1,318	188	320	5,470	390	6,670	5,280	1,164	6,444	
Shell Rock Rapids		335	....	30	....	85	232	....	275	750	675	....	1,350	30	310	846	375	1,020	805	181	986	
Pyramid Rapids		280	....	34	....	70	216	....	235	726	646	....	1,508	34	245	757	330	1,020	800	190	990	
Total — Undeveloped powers		....	....	626	....	....	6,172	....	....	20,607	18,346	....	....	626	....	20,129	....	27,015	21,651	4,062	25,713	
Grand total		....	....	1,111	....	....	11,771	....	....	38,853	34,651	....	....	1,117	....	36,445	....	50,953	40,974	7,310	48,284	

* Estimated.

y of Effects of Proposed Storage on Saranac River

Power available n average year with nstallation in Column VI h. p.-years per annum	Estimated available flow for 60 per cent. of average year	Capacity of turbines at 80 per cent. efficiency for 24-hour power 60 per cent. of average year	Power available in average year with flow in Column X and installation in Column XI h. p.-years per annum	Conditions After Regulation by 4.0 Billion Cubic Feet of Storage in Proposed Saranac Lake Reservoir, Regulated for Tefft Pond											
				Power added to natural stream flow by proposed reservoir with present installation and head h. p.-years per annum	Elevation of proposed crest of dam or top of flashboards	Ultimate working head	Minimum regulated flow in second-feet, dryest year	Continuous 24-hour h. p. available, dryest year	Regulated flow available for 60 per cent. of average year	Capacity of turbines at 80 per cent efficiency for 24-hour power 60 per cent. of average year	Power supplied by natural flow with installation in Column XIX h. p.-years per annum	Additional power afforded by proposed regulation in average year, after economic development, h. p.-years per annum	Total hydraulic power available in average year, h. p.-years per annum. (Sum of Column XX and Column XXI)	Auxiliary Power Required to Maintain Continuous 24-hour Power With Installation of Column XIX	
														Rated horsepowe[1]	Horsepower-years per annum
IX	X	XI	XII	XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV
644	400	510	485	77											
49	60	55	39	14	112	15	405	552	615	840	682	105	787	288	53
33	25	20	14	7											
293	243	199	176	17											
124	121	90	88	16	122	10	405	368	615	559	454	70	524	191	35
102	121	99	88	15											
1,230	485	970	860	150	183	22	405	810	615	1,230	998	154	1,152	420	78
659	485	618	548	103	206	14	405	516	615	783	635	98	733	267	50
1,960	485	1,850	1,040	308	249	42	405	1,546	615	2,350	1,967	294	2,201	804	149
1,500	485	1,190	1,050	185	281	27	405	995	615	1,516	1,227	189	1,416	515	94
142	235	192	171	8	362	9	400	327	595	487	395	62	457	160	30
132	235	150	133	16											
5,830	460	6,520	5,850	690	579	156	395	5,660	590	8,370	6,782	1,082	7,864	2,770	506
3,050	460	2,720	2,440	518	648	65	395	2,335	590	3,485	2,824	450	3,274	1,150	211
75	420	306	272	....	759	11	385	385	540	546	435	75	510	155	30
1,330	275	1,425	1,265	165	1,408	57	300	1,552	375	1,942	1,542	348	1,890	390	52
1,290	245	1,158	1,040	308	1,462	52	260	1,230	340	1,607	1,262	296	1,558	377	49
122	82	82	73	....	1,527	11	100	100	235	235	180	25	205	135	30
111	83	83	73	10											
18,676	....	18,246	16,305	2,607	....	491	....	16,316	....	23,938	19,323	3,248	22,571	7,622	1,367
....	485	925	825	....	148	21	405	773	615	1,175	953	147	1,100	402	75
....	460	3,136	2,810	....	726	75	395	2,605	590	4,020	3,256	520	3,776	1,325	244
....	405	8,910	7,870	....	1,035	242	380	8,360	520	11,440	9,215	1,620	10,835	3,080	605
....	395	1,290	1,150	....	1,102	36	375	1,228	510	1,670	1,342	240	1,582	442	88
....	285	4,870	4,370	....	1,318	188	320	5,470	390	6,670	5,280	1,164	6,444	1,200	226
....	275	750	675	....	1,350	30	310	846	375	1,020	805	181	986	174	34
....	235	726	646	....	1,508	34	245	757	330	1,020	800	190	990	263	30
....	....	20,607	18,346	....	....	626	....	20,129	....	27,015	21,651	4,062	25,713	6,886	1,362
....	....	38,853	34,651	....	....	1,117	....	36,445	....	50,953	40,974	7,310	48,284	14,508	2,669

Rapids Below Tefft Pond

STATE OF NEW YORK
CONSERVATION COMMISSION
DIVISION OF INLAND WATERS
POWER-PERCENTAGE-OF-TIME CURVES

SARANAC RIVER AT PLATTSBURG

JANUARY 1915

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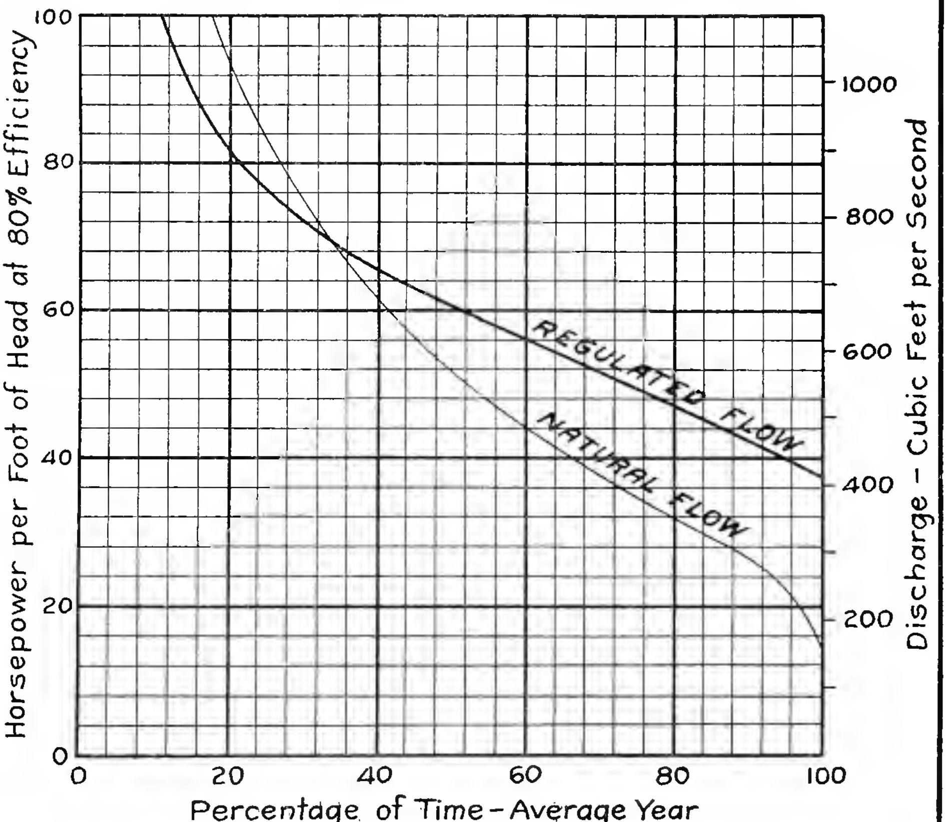
NOTE:-
Regulated flow line shows resulting regulation from 4.0 billion cubic feet of storage in proposed Saranac Lake Reservoir.



Explanation of Table IV

This table shows the principal details of head, wheel installation, estimated streamflow, etc., at each of the present plants and at all undeveloped power sites affected by the proposed Saranac Lake reservoir. The first six columns are self-explanatory. Column VII shows the estimated minimum monthly streamflow, based on the Plattsburg records as explained on page 5. Column VIII shows the amount of continuous 24-hour power available with the head in Column V and the flow in Column VII; Column IX, the amount of power available with the given head and the present wheel installation, a turbine efficiency of 80 per cent. being assumed in each case. Columns X and XI show the estimated flow and wheel capacity available for 60 per cent. of the average year, and Column XII, the amount of power, in horsepower-years per annum, which would be produced with the given flow and the installation shown in Column XI. Column XIII shows the amount of power which the proposed regulation would add to the output of the natural flow of the stream with the present installation and head. It is to a certain extent a measure of the benefits which would result if the proposed reservoir were to be built for the present plants only. It will be noticed that in one or two instances the apparent benefit amounts to little or nothing. This is due to a relatively high installation to take unusual loads for a short time, or to utilize flood flows during but a short period each year. In these cases, of course, the table does not represent the true benefit received from the more steady flow due to regulation.

Columns XIV and XV are comparable with Columns IV and V, showing the elevation of crest of dam and working head at each point, after the entire available head shall have been completely developed. It should be here noted that all heads which are wholly or partially developed are listed under "Developed Heads," and therefore that where the head shown in Column XV is greater than that in Column V, a portion of the increased power shown in succeeding columns is due to increased head, and should properly be considered as "undeveloped power."

Columns XVI and XVII show the minimum flow and continuous power available with the proposed regulation, and Columns XVIII and XIX, the streamflow and power for 60 per cent. of the average year (with heads shown in Column XV). Column XX shows the power supplied by the natural flow of the stream with the head in Column XV and the installation in Column XIX; Column XXI, the additional power afforded by regulations; and Column XXII, the total hydraulic power available after regulation and complete development. As before stated, it has been assumed that an installation which can run at full capacity 60 per cent. of the average year represents "complete development." Column XXIII shows the auxiliary installation necessary to maintain the full-capacity output shown in Column XIX, and Column XXIV shows the amount of auxiliary power required in the ordinary year for continuous year-round power.

At the foot of Column XXI, it is seen that after complete development the proposed reservoir would increase the total power output by 7,310 horsepower-years per annum. The estimated cost of the reservoir is $614,000; therefore, the "storage investment" amounts to but $84 per horsepower for this increased power, which, in fact, replaces costly auxiliary power.